Engineers Construction, Inc.
98 Engineers Drive
Williston, VT 05495
TEL: 802-863-6389 FAX: 802-862-9703

Matthew S. Fisher
Vice President
East Coast Signals, Inc.

April 3, 2015

RE: Waterbury IM 0890-2(43) (RE-ADVERTISED)

Matt,

Please allow this document to serve as our submittal package. In regards to the bore profile we will provide bore logs for as built information after the bore is complete. The bore plan as reflected on the States for construction drawing will be used unless it needs to be altered due to existing utilities or obstructions that may make the bore not feasible to achieve as designed. Field verification of utilities will dictate the best plan. We can visit the site next week to discuss if you wish.

Contents:

1. Frac out contingency plan
2. MSDS Sheets on all bore additives
3. Specification sheet on selected directional drill
4. Specification sheet on subsite locating system
5. Cut sheet on tracer wire
6. Procedure narrative
7. Pipe specification sheet on HDPE pipe

Section # 1: Frac out contingency plan

- All stages of HDD operations involve circulating drilling fluid. Among other purposes, the drilling fluid is used in the HDD process to transport soil and rock cuttings to the surface and to stabilize the hole. The fluid also reduces drilling friction, cools and cleans the drill cutters, when required transmits hydraulic power to the drill bit, and performs the hydraulic excavation of the cuttings.

  The primary component of the drilling fluid used in HDDs for pipeline installation is water. To enhance the fluid performance, a viscosifier (typically naturally occurring bentonite clay) is added to the water to improve its properties. Specific soils and drilling conditions may require the addition of various constituents to vary the properties of the drilling fluid to meet the needs of the particular

situation. Because the drilling mud consists mainly of a bentonite clay-water mixture, it is not considered to be hazardous or toxic.

The most likely occurrence of inadvertent fluid releases developing during drilling operations is a result of soil conditions; sub surface exploration work is done for best design planning and to minimize this potential. When this event occurs it is a condition in which the drilling mud is released through fractures in the soil and migrates towards the surface. Inadvertent fluid release usually occurs when the down-hole pressures are too high and overcome the restraining forces of the surrounding formation. This most often occurs during the pilot hole drilling operations when the pressures are the highest. Inadvertent fluid release is most common near the drill entry and exit locations, but can occur at any location along the drill path.

The following plan identifies operational procedures and responsibilities for the prevention, containment, and clean-up of inadvertent fluid releases associated with HDD operations.

HDD operations are typically designed to include a drilling fluid fracture or overburden breakout monitoring program to minimize the potential of drilling fluid breakout. It is anticipated that the drilling depths in the overburden will be sufficiently deep to avoid pressure induced breakout of drilling fluids based primarily on estimates of overburden thickness and porosity. Nevertheless, a visual an operational monitoring program will be implemented during the operation. This effort will include.

- Visual monitoring of ground surface and waters by drilling operation monitoring staff on a daily basis to observe potential drilling fluid breakout points.
- Drilling fluid volume monitoring by technicians on a daily basis throughout the drilling and reaming operation of the HDD install.
- Monitoring and adjustment as necessary of the drilling fluid pressure and advance rate of the bore.
- Development and implementation of a fluid loss response plan and protocol by the drill operator in the event that a fluid loss occurs. These response plans include drill stem adjustments, injection of loss circulation additives, such as Diamond seal, that can be mixed with drilling fluids at the mud tanks. And other mitigation measures as appropriate.
- Use of appropriate clean up and removal equipment in the event of a release to the upland surfaces where possible.

o Additional preventive measures will be set up around the drill entry and exit holes as appropriate. These measures may include:

- Small slurry pits, silt fence and hay bales to contain and properly dispose of drill cuttings (soil), loose sediment, and localized fluids.
- Additional earth berms as needed for containment
- A vacuum or vacuum truck and or pumps for the collection and clean-up of slurry.

- A 4,000 gallon vacuum truck will be used to haul the slurry after collection to an approved disposal area.

Section # 2: MSDS Sheets on all bore additives

- Please see attached sheets. MSDS sheets are also on site with our drill crews at all times
  - Marked as exhibit "A" - 42 Pages

Section # 3: Specification sheet on selected directional drill

- Please see attached cut sheet on proposed Ditch Witch 3020 machine
  - Marked as exhibit "B" - 1 Page

Section # 4: Specification sheet on subsite locating system

- Please see attached manufacturers cut sheet
  - Marked as exhibit "C" - 12 Pages

Section # 5: Cut sheet on tracer wire

- Please see attached manufacturers cut sheet
  - Marked as exhibit "D" - 1 Page

Section # 6: Procedure narrative

- Upon mobilization complete site set up. Stage one of the directional drilling will begin with a pilot hole process. The second stage of the work will be pre-reaming of the bore hole (depending upon ground conditions encountered this process may occur multiple times). The final stage will be the pull back. Please see attached diagram showing these stages.
  - Marked as exhibit "E" - 1 Page

Section # 7: Pipe specification sheet on HDPE pipe

- Please see attached manufacturers cut sheet. We will be using 10" DR9 pipe. Please note this pipe will not be ordered until after we have a successful pilot bore hole. This may result in a short delay. Fusing of HDPE will be completed by certified fusing technicians using manufacturers specifications.
  - Marked as exhibit "F" - 1 Page

Sincerely,

Tom Loyer
Project Manager

EXHIBIT "A"

BORE-GEL®

Boring Fluid System – U.S. Patent Number 5,723,416

Description

BORE-GEL® single-sack boring fluid system is specially formulated for use in horizontal directional drilling (HDD) applications. BORE-GEL fluid system is a proprietary blended product using high-quality Wyoming sodium bentonite When BORE-GEL fluid system is mixed with fresh water, it develops an easy-to-pump slurry with desirable fluid properties for HDD.

Applications/Functions

The use of BORE-GEL fluid system promotes the following:

- Optimum gel strength for cuttings suspension and transport
- Pumpable slurry with minimal viscosity
- High reactive solids concentration for improved borehole stability in poorly consolidated/cemented sands and gravel formations
- Reduced filtration via a thin filter cake with low permeability
- Lubrication of pipe in microtunneling operations

Advantages

- Minimizes the number of boring fluid products required
- Easy to mix and fast to yield
- Low viscosity minimizes pump pressures
- Provides lubricity for pulling product line
- Can be used in Water Wells in unconsolidated formations or when additional gel strengths are required to compensate for low annular velocity
- NSF/ANSI Standard 60 certified

Typical Properties

Appearance	Tan to gray powder
pH (4% slurry or 15 lb/bbl)	10.2
Bulk density, lb/ft^3	68 to 72 (compacted)

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Rev. 2/24/2011 · IDP 032

BORE-GEL is a registered trademark of Halliburton

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Recommended Treatment

Add slowly and uniformly through a high-shear, jet-type mixer over one or more cycles of the volume of slurry. Continue to circulate and agitate the slurry until all unyielded bentonite is dispersed.

Approximate amounts of BORE-GEL® fluid system added to fresh water		
Boring Application	**lb/100 gal**	**kg/m³**
Normal boring conditions	25 – 35	30 – 42
Poorly consolidated sand/gravel	35 – 60	42 – 72
Lubrication fluid for microtunneling	50 – 60	60 – 72

Packaging

BORE-GEL boring fluid system is packaged in a 50-lb (23-kg) multiwall paper bag.

Availability

BORE-GEL boring fluid system can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: BORE-GEL®

Revision Date: 16-Mar-2012

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BORE-GEL®
Synonyms: None
Chemical Family: Mineral
Application: Viscosifier

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	Not applicable	Not applicable
Crystalline silica, tridymite	15468-32-3	0 - 1%	0.05 mg/m³	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, cristobalite	14464-46-1	0 - 1%	0.025 mg/m³	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, quartz	14808-60-7	1 - 5%	0.025 mg/m³	$\frac{10\ mg/m^3}{\%SiO2 + 2}$

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	All standard firefighting media.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Health 0*, Flammability 0, Physical Hazard 0 , PPE: At

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 12 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.
Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (95%)
Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Powder
Color:	Light brown or Gray
Odor:	Mild earthy
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.5
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	53 - 80
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Slightly soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.

Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A). Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.
Chronic Effects/Carcinogenicity	Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis. Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.
Other Information	For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).
Toxicity Tests	

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not determined
Bio-accumulation	Not determined

Ecotoxicological Information

Acute Fish Toxicity:	TLM96: 10000 ppm (Oncorhynchus mykiss)
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	If practical, recover and reclaim, recycle, or reuse by the guidelines of an approved local reuse program. Should contaminated product become a waste, dispose of in a licensed industrial landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.
WHMIS Hazard Class	D2A Very Toxic Materials Crystalline silica

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

NO-SAG®

Suspension Enhancer

Description

NO-SAG® suspension enhancer is a premium quality, powdered biopolymer that is used to enhance the carrying capacity of both clay and polymer-based drilling fluids without significantly increasing the viscosity of the slurry. NO-SAG is easily dispersible in fresh or brackish water.

Applications/Functions

The use of NO-SAG suspension enhancer promotes the following:

- Increased gel strength of the drilling fluid for better suspension of the drilled cuttings, coarse sand and gravel
- Enhanced carrying capacity for solids suspension at lower viscosity to further ensure flowability on longer length bores and backreams
- Improved resistance to contamination when drilling in brackish and salt water environments

Advantages

- Can mix easily into pre-hydrated bentonite-based fluids
- Helps enhance system by increasing the suspension properties of the base drilling fluid with a minimal increase in viscosity
- Small packaging for ease of handling and reduction of waste

Typical Properties

Appearance	Free-flowing beige powder
Specific gravity	1.6
Bulk density (lb/ft^3)	45
pH (0.14% or 0.5 lb/bbl)	7.1 - 7.4

Recommended Treatment

Mix 2-4 pounds (1-2 bags) of NO-SAG suspension enhancer per 300 gallons (0.8-1.6 kg/m^3) of drilling fluid slurry.

Approximate Amounts of NO-SAG® suspension enhancer Added to Water-Based Drilling Fluids

BORE-GEL® drilling fluid (30 – 50 lb/100 gal)		QUIK-GEL® drilling fluid (15 – 40 lb/100 gal)		POLY-BORE™ slurry (0.5 – 1 lb/100 gal)	
lb/100 gal	kg/m^3	lb/100 gal	kg/m^3	lb/100 gal	kg/m^3
0.5 – 1.5	0.6 – 1.8	0.5 – 2	0.6 – 2.4	1 – 4	1.2 – 4.8

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POLY-BORE is a trademark of Halliburton

Rev. 02/22/2011 · iDP 047

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Packaging

NO-SAG® suspension enhancer is packaged in a plastic bucket containing 10 airtight sealed plastic bags. Each bag contains 2 pounds (0.91 kg).

Availability

NO-SAG suspension enhancer can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area Baroid IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: NO-SAG®

Revision Date: 02-Jan-2013

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: NO-SAG®
Synonyms: None
Chemical Family: Carbohydrate
Application: Viscosifier

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Xanthan gum	11138-66-2	60 - 100%	10 mg/m^3	15 mg/m^3

3. HAZARDS IDENTIFICATION

Hazard Overview May cause eye irritation. Airborne dust may be explosive.

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin Wash with soap and water. Get medical attention if irritation persists.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Notes to Physician Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	400
Autoignition Temperature (C):	204
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	Water fog, carbon dioxide, foam, dry chemical.
Special Exposure Hazards	Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential. Decomposition in fire may produce toxic gases.
Special Protective Equipment for Fire-Fighters	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Health 0, Flammability 0, Physical Hazard 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions	Slippery when wet. Avoid creating or inhaling dust.
Storage Information	Store away from oxidizers. Store in a cool, dry location.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use in a well ventilated area.
Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	White to yellow
Odor:	Slight
pH:	7
Specific Gravity @ 20 C (Water=1):	1.5
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	35-55
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	1,000,000

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Strong oxidizers.
Hazardous Decomposition Products	Carbon monoxide and carbon dioxide.
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	May impede respiration.
Skin Contact	None known.
Eye Contact	May cause mild eye irritation.
Ingestion	None known
Aggravated Medical Conditions	None known.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
Other Information	None known.
Toxicity Tests	

Oral Toxicity:	LD50: > 5000 mg/kg (Rat)
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Not determined
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	BOD(5 Day): 200 mg/g COD: 1600 mg/g
Bio-accumulation	Not determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	TLM96: > 75000 ppm (Mysidopsis bahia)
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	None
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	All components listed do not apply to the California Proposition 65 Regulation.
MA Right-to-Know Law	Does not apply.
NJ Right-to-Know Law	Does not apply.
PA Right-to-Know Law	Does not apply.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.
WHMIS Hazard Class	Un-Controlled

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

EZ-MUD®

Polymer Emulsion

Description

EZ-MUD® liquid polymer emulsion contains partially hydrolyzed polyacrylamide/polyacrylate (PHPA) copolymer and is used primarily as a borehole stabilizer to prevent reactive shale and clay from swelling and sloughing. EZ-MUD polymer emulsion is also added to low-solids drilling fluids to increase lubricity, fluid viscosity, and to improve carrying capacity of air/foam injection fluids.

Applications/Functions

The use of EZ-MUD liquid polymer assists or promotes the following:

- Stabilize reactive shale and clay formations
- Improve borehole stability
- Enhance slurry rheological properties
- Alleviate mud rings, bit balling and booting-off in clay formations
- Reduce drill pipe torque and pumping pressure
- Minimize rod chatter in diamond core drilling
- Create "stiff-foam" and maintain foam integrity
- Flocculate non-reactive solids in reserve pit at low concentrations

Advantages

- Mixes easily with minimum shear in fresh water
- Helps provide effective clay and shale stabilization with lower viscosity
- Helps impart high degree of lubricity
- Non-fermenting
- Breaks down chemically with household bleach (sodium hypochlorite)
- NSF/ANSI Standard 60 Certified

Typical Properties

Appearance	Thick, opaque white liquid
Density	8.5 lb/gal (1.02 g/cm^3)
pH (1 quart per 100 gallons water)	8.5
Flash point, PMCC °F, °C	>200 (>93.3)
Thermal stability, °F, °C	250 (121)

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Rev.03/22/2011 · IDP 008

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Recommended Treatment

Approximate Amounts of EZ-MUD® Polymer Added to Drilling Fluids			
Added to Fresh Water (To formulate a clay-free drilling fluid)	**Quarts/ 100 gal**	**Pints/bbl**	**Liters/m³**
• To stabilize reactive clay and shale	0.5 - 2.0	0.5 - 1.75	1.25 - 5.0
• To retard rod vibration, reduce torque and pumping pressure	1.0 - 2.0	1.0 - 1.75	2.5 - 5.0
Added to QUIK-GEL® or BORE-GEL® Drilling Fluid or air/foam injection liquid	**Quarts/ 100 gal**	**Pints/bbl**	**Liters/m³**
• To retard reactive shale and clay and enhance lubricity	0.5 - 1.0	0.5 - 1.0	1.25 - 2.5
• To improve foam performance and hole conditions	0.5 - 1.0	0.5 - 1.0	1.25 - 2.5

Notes:

- Make-up water used to mix EZ-MUD liquid polymer should meet the following quality:
  total chloride less than 1500 ppm (mg/L)
  total hardness less than 150 ppm as calcium
  total chlorine less than 50 ppm
  water pH between 8.5-9.5
- Reduce total hardness of make-up water by adding soda ash (sodium carbonate) at 0.5 to 1 pound per 100 gallons (0.6 - 1.2 kg/m³) of make-up water.
- EZ-MUD liquid polymer can be chemically broken down with liquid bleach in regular household concentration (5% sodium hypochlorite). Use one gallon of liquid bleach per 100 gallons (10 liters/m³) of fluid formulated with EZ-MUD liquid polymer. **Do not use perfumed liquid bleach or solid calcium hypochlorite.**

Packaging

EZ-MUD liquid polymer is packaged in 5-gal (19-liter) and 1-gal (3.8-liter) plastic containers.

Availability

EZ-MUD liquid polymer can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: EZ-MUD®

Revision Date: 02-Dec-2013

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: EZ-MUD®
Synonyms: None
Chemical Family: Blend
Application: Shale Inhibitor

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT (w/w)	ACGIH TLV-TWA	OSHA PEL-TWA
Hydrotreated light petroleum distillate	64742-47-8	10 - 30%	Not applicable	Not applicable

3. HAZARDS IDENTIFICATION

Hazard Overview
May cause eye, skin, and respiratory irritation. May cause headache, dizziness, and other central nervous system effects. May be harmful if swallowed.

4. FIRST AID MEASURES

Inhalation
If inhaled, remove to fresh air. If not breathing give artificial respiration, preferably mouth-to-mouth. If breathing is difficult give oxygen. Get medical attention.

Skin
Wash with soap and water. Get medical attention if irritation persists. Remove contaminated shoes and discard.

Eyes
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion
Get medical attention! If vomiting occurs, keep head lower than hips to prevent aspiration.

Notes to Physician
Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	> 200
Flash Point/Range (C):	Not Determined
Flash Point Method:	PMCC
Autoignition Temperature (F):	> 392
Autoignition Temperature (C):	> 200
Flammability Limits In Air - Lower (%):	Not Determined
Flammability Limits In Air - Upper (%):	Not Determined

Fire Extinguishing Media	Water fog, carbon dioxide, foam, dry chemical.
Special Exposure Hazards	Decomposition in fire may produce toxic gases. Use water spray to cool fire exposed surfaces.
Special Protective Equipment for Fire-Fighters	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.
NFPA Ratings:	Health 2, Flammability 1, Reactivity 0
HMIS Ratings:	Health 2, Flammability 1, Physical Hazard 0 , PPE: B

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment.
Environmental Precautionary Measures	Prevent from entering sewers, waterways, or low areas.
Procedure for Cleaning / Absorption	Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions	Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Wash hands after use. Launder contaminated clothing before reuse.
Storage Information	Store away from oxidizers. Keep container closed when not in use.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	A well ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.
Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	Organic vapor respirator with a dust/mist filter. (A2P2/P3) In high concentrations, supplied air respirator or a self-contained breathing apparatus.
Hand Protection	Impervious rubber gloves.

Skin Protection	Rubber apron.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Color:	White to gray
Odor:	Mild hydrocarbon
pH:	6-8
Specific Gravity @ 20 C (Water=1):	1.0
Density @ 20 C (lbs./gallon):	8.3
Bulk Density @ 20 C (lbs/ft3):	Not Determined
Boiling Point/Range (F):	347
Boiling Point/Range (C):	175
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	0.002
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	70
Evaporation Rate (Butyl Acetate=1):	< 1
Solubility in Water (g/100ml):	Partially soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	Keep away from heat, sparks and flame.
Incompatibility (Materials to Avoid)	Strong oxidizers.
Hazardous Decomposition Products	Ammonia. Oxides of nitrogen. Carbon monoxide and carbon dioxide.
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.

Sympotoms related to exposure

Acute Toxicity

Inhalation	May cause mild respiratory irritation.
Eye Contact	May cause mild eye irritation.
Skin Contact	May cause mild skin irritation.

Ingestion	Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal. May cause central nervous system depression including headache, dizziness, drowsiness, muscular weakness, incoordination, slowed reaction time, fatigue blurred vision, slurred speech, giddiness, tremors and convulsions.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Hydrotreated light petroleum distillate	64742-47-8	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	5.2 mg/L (Rat) 4 h

12. ECOLOGICAL INFORMATION

Ecotoxicological Information

Ecotoxicity Product

Acute Fish Toxicity: TLM96: >1000 mg/l (Pimephales promelas)
Acute Crustaceans Toxicity: TLM48: 98 mg/l (Acartia tonsa)
Acute Algae Toxicity: EC50: 16.70 mg/l (Skeletonema costatum)

Ecotoxicity Substance

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Daphnia Magna (Water Flea)
Hydrotreated light petroleum distillate	64742-47-8	EC50(72h): > 10,000 mg/L (Skeletonema costatum) (ISO 10253)	LC50 96h): > 10,000 mg/L (Scophthalmus maximus) (OSPARCOM 1995)	No information available	LC50(48h): > 10,000 mg/L (Acartia tonsa) (ISO 14669)

12.2 Persistence and degradability
No information available

12.3 Bioaccumulative potential

Substances	Log Pow
Hydrotreated light petroleum distillate	7.5

12.4 Mobility in soil
No information available

12.5 Results of PBT and vPvB assessment
No information available.

12.6 Other adverse effects

13. DISPOSAL CONSIDERATIONS

Disposal Method Disposal should be made in accordance with federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	All components listed do not apply to the California Proposition 65 Regulation.
MA Right-to-Know Law	Does not apply.
NJ Right-to-Know Law	Does not apply.
PA Right-to-Know Law	Does not apply.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.
WHMIS Hazard Class	D2B Toxic Materials

16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS
Not applicable

Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

DIAMOND SEAL®

Absorbent Polymer for Lost Circulation

Description

DIAMOND SEAL® lost circulation material is a 100% active, water-swellable, synthetic polymer. DIAMOND SEAL polymer LCM absorbs hundreds of times its own weight in water. It is intended for use primarily as a lost circulation material for horizontal directional drilling (HDD).

Applications/Functions

The use of DIAMOND SEAL absorbent polymer can assist the following:

- Lost circulation material for horizontal directional drilling
- Prevent inadvertent returns in river crossing applications
- Stabilize borehole in cobble and gravel
- Stabilize unconsolidated formations

Advantages

- Rapid water absorption
- Effective in mitigating lost circulation
- Economical – small quantity yields large volume
- Easy to use
- Non-fermenting

Typical Properties

Appearance	off-white crystals
Specific gravity	0.75
Dry screen analysis	96% through 5 mesh (4.0 mm)
Swelling capacity in fresh water	3.5 ft^3/lb (0.22 m^3/kg)

Recommended Treatment

For slug treatment:

- Add 0.5 to 1 pound (0.25-0.5 kg) DIAMOND SEAL polymer LCM per joint

As a pill:

- Add DIAMOND SEAL polymer LCM at 10 - 20 lb/100 gallons of drilling fluid
- Add DIAMOND SEAL polymer LCM at 12 - 24 kg/m^3 of drilling fluid

Treatment for Loss of Circulation or Inadvertent Returns in HDD Operations:

(Prior to pumping remove all in-line screens in circulating system)
Add the following to existing drilling fluid and displace:

BAROLIFT®	-	0.25 - 0.5 lb/100 gallons (0.3 - 0.6 kg/m^3)
N-SEAL™	-	3 - 5 lb/100 gallons (3.6 - 6.0 kg/m^3)
DIAMOND SEAL	-	10 - 20 lb/100 gallons (12 - 24 kg/m^3)

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Rev. 2/25/2011 - IDP 052

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N-SEAL is a trademark of Halliburton

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Packaging	DIAMOND SEAL® absorbent polymer is packaged in 10-lb (4.5-kg) resealable plastic containers.
Availability	DIAMOND SEAL absorbent polymer can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: DIAMOND SEAL

Revision Date: 03-Aug-2012

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: DIAMOND SEAL
Synonyms: None
Chemical Family: Polymer
Application: Additive

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Contains no hazardous substances	Mixture	60 - 100%	Not applicable	Not applicable

3. HAZARDS IDENTIFICATION

Hazard Overview May cause eye irritation.

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin Wash with soap and water. Get medical attention if irritation persists.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Notes to Physician Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	Carbon Dioxide, Dry Chemicals, Foam.
Special Exposure Hazards	Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.
Special Protective Equipment for Fire-Fighters	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.
NFPA Ratings:	Health 1, Flammability 1, Reactivity 0
HMIS Ratings:	Health 1, Flammability 1, Reactivity 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions	Avoid creating or inhaling dust. Wash hands after use. Slippery when wet.
Storage Information	Store away from oxidizers. Store in a dry location.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	A well ventilated area to control dust levels.
Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	White
Odor:	Odorless
pH:	4-11
Specific Gravity @ 20 C (Water=1):	0.65- 0.85
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	40-50
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None known.
Incompatibility (Materials to Avoid)	Strong oxidizers.
Hazardous Decomposition Products	Oxides of nitrogen. Ammonia. Hydrocarbons. Carbon monoxide and carbon dioxide. In the event of oxygen depletion, hydrocyanic acid can be formed.
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	May cause mild respiratory irritation.
Skin Contact	None known.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	None known.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
Other Information	None known.
Toxicity Tests	

Oral Toxicity:	LD50: > 5000 mg/kg (Rat)
Dermal Toxicity:	LD50: > 2000 mg/kg (Rabbit)
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Not determined
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not readily biodegradable.
Bio-accumulation	Not determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	None
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.
WHMIS Hazard Class	Un-Controlled

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

END OF MSDS

EZ-SEAL®

One Sack Grouting and Plugging Material

Description

EZ-SEAL® one-sack granular bentonite product is intended for use as an easily mixed grouting and plugging material.

Applications/Functions

The use if EZ-SEAL bentonite assists or promotes the following:

- Sealing or grouting of plastic and steel casings
- Plugging abandoned boreholes and filling earthen cavities
- Grouting of loops for ground source heat pumps
- Reduction of lost circulation
- Stabilization of broken and unconsolidated formations

Advantages

- One-sack product
- Easy to mix and apply, just add fresh water
- Flexibility in application rate and grout set time
- Good structural integrity
- Low permeability
- No heat of hydration
- Minimal depletion of grout level after emplacement
- NSF/ANSI Standard 60 certified

Typical Properties

Appearance	Bluish-tan granules
Volume, ft^3/sack	0.70
Thermal conductivity, btu/hr ft °F (watts/meter °C)	0.41 (0.70)
Permeability, cm/sec	1.0×10^{-9}

Recommended Treatment

Add one 50-lb (22.7 kg) sack of EZ-SEAL material to appropriate amount of make-up water to obtain the desired solids content:

% Solids grout	15	20	23
Water, gallons	33	24	20
Water, liters	125	91	76
Yield volume, gallons	35.3	26.3	22.3
Yield volume, liters	133.6	99.6	84.4

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Rev. 03/2011 · IDP 051

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Recommended Treatment (continued)

Once EZ-SEAL® bentonite is added to the mixing water, the slurry will have an "oatmeal consistency" containing un-yielded and partially hydrated bentonite granules. It is recommended the product be blended only long enough to gain suspension of the EZ-SEAL material. Immediately tremie the grout into place to allow the bentonite granules to hydrate and swell in situ. Do not over mix and do not use a centrifugal pump.

Additional Information

- The grouting material and method selected will depend upon the specific subsurface environment including all prevailing geological and hydrological factors and any existing regulatory requirements.
- The use of bentonite may not be appropriate in environments where the formation water chemistry has a total hardness greater than 500 parts per million and/or a chloride content of greater than 1500 parts per million.
- If questions arise regarding subsurface environments it is always best to consult your local Baroid IDP representative to determine if the Baroid product of choice is appropriate for the given conditions.

Packaging

EZ-SEAL bentonite is packaged in 50-lb (22.7 kg) multiwall paper bags, containing 0.7 ft^3 (0.02 m^3).

Availability

EZ-SEAL bentonite can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: EZ SEAL LIQUID PHASE

Revision Date: 03-Jan-2012

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: EZ SEAL LIQUID PHASE
Synonyms: None
Chemical Family: Blend
Application: Shale Inhibitor

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Hydrotreated light petroleum distillate	64742-47-8	60 - 100%	Not applicable	Not applicable

3. HAZARDS IDENTIFICATION

Hazard Overview
May cause eye, skin, and respiratory irritation. May cause headache, dizziness, and other central nervous system effects. May be harmful if swallowed.

4. FIRST AID MEASURES

Inhalation
If inhaled, remove to fresh air. If not breathing give artificial respiration, preferably mouth-to-mouth. If breathing is difficult give oxygen. Get medical attention.

Skin
Wash with soap and water. Get medical attention if irritation persists. Remove contaminated shoes and discard.

Eyes
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion
Get medical attention! If vomiting occurs, keep head lower than hips to prevent aspiration.

Notes to Physician
Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	160
Flash Point/Range (C):	71
Flash Point Method:	PMCC
Autoignition Temperature (F):	> 392
Autoignition Temperature (C):	> 200
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	Water fog, carbon dioxide, foam, dry chemical.
Special Exposure Hazards	Decomposition in fire may produce toxic gases. Use water spray to cool fire exposed surfaces.
Special Protective Equipment for Fire-Fighters	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.
NFPA Ratings:	Health 2, Flammability 1, Reactivity 0
HMIS Ratings:	Health 2, Flammability 1, Physical Hazard 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment.
Environmental Precautionary Measures	Prevent from entering sewers, waterways, or low areas.
Procedure for Cleaning / Absorption	Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions	Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Wash hands after use. Launder contaminated clothing before reuse.
Storage Information	Store away from oxidizers. Keep container closed when not in use.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	A well ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.
Respiratory Protection	Organic vapor respirator with a dust/mist filter. In high concentrations, supplied air respirator or a self-contained breathing apparatus.
Hand Protection	Impervious rubber gloves.
Skin Protection	Rubber apron.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Color:	White to off white
Odor:	Mild hydrocarbon

9. PHYSICAL AND CHEMICAL PROPERTIES

pH:	6-8
Specific Gravity @ 20 C (Water=1):	0.94
Density @ 20 C (lbs./gallon):	7.8
Bulk Density @ 20 C (lbs/ft3):	58.6
Boiling Point/Range (F):	347
Boiling Point/Range (C):	175
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	0.002
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	70
Evaporation Rate (Butyl Acetate=1):	< 1
Solubility in Water (g/100ml):	Partially soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	Keep away from heat, sparks and flame.
Incompatibility (Materials to Avoid)	Strong oxidizers.
Hazardous Decomposition Products	Ammonia. Oxides of nitrogen. Carbon monoxide and carbon dioxide.
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	May cause respiratory irritation. May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.
Skin Contact	May cause skin irritation.
Eye Contact	May cause severe eye irritation.
Ingestion	Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal. May cause central nervous system depression including headache, dizziness, drowsiness, muscular weakness, incoordination, slowed reaction time, fatigue blurred vision, slurred speech, giddiness, tremors and convulsions.
Aggravated Medical Conditions	Lung disorders.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
Other Information	None known.

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Not determined
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not determined
Bio-accumulation	Not determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

DOT (Bulk)
NA1993, Combustible Liquid, N.O.S., Combustible Liquid, III
(Contains Petroleum Distillates)

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	All components listed do not apply to the California Proposition 65 Regulation.
MA Right-to-Know Law	Does not apply.
NJ Right-to-Know Law	Does not apply.
PA Right-to-Know Law	Does not apply.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.
WHMIS Hazard Class	D2B Toxic Materials

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

END OF MSDS

FUSE-IT®

Synthetic Polymer Lost Circulation Material

Description

FUSE-IT® lost circulation material is a fast-acting, synthetic polymer-based lost circulation material designed to help seal off even the most severe loss zones in as little as 30 minutes allowing the operator to return to normal drilling activities.

Applications/ Functions

- Lost circulation material for vertical and horizontal drilling applications
- Suitable for addressing fractured and vugular formations
- Effective LCM for sand, gravel and cobble environments
- Can stabilize unconsolidated formations

Advantages

- NSF/ANSI Standard 60 certified
- Rapid reaction upon contact with water
- Enables quick response to loss of circulation
- Easy to use
- Non-fermenting
- Temperature tolerant
- Compatiable with other Baroid products

Typical Properties

• Appearance	Milky white liquid
• Specific gravity	1.25
• Flash Point, °F, (°C)	>212°F, (>100°C)

Recommended Treatment

As a slug treatment:

- Add 5-10 gallons (20-40 liters) of vegetable oil directly into drillstring to pre-coat metal surfaces of drillstring
- Follow immediately into drillstring with 1-2 buckets of FUSE-IT
- Follow addition of FUSE-IT lost circulation material with 5-10 gallons (20-40 liters) of vegetable oil and displace. Following displacement allow 30-60 minutes for hydration prior to attempt to regain circulation

As a pill:

- Add FUSE-IT lost circulation material to drilling fluid at a concentration of 0.5-1.0 % by volume (2-4 qts/100 gallons or 5-10 liters/m^3) and displace mixture immediately into zone of interest.

Packaging

FUSE-IT lost circulation material is packaged in 5-gallon (18.9 L) plastic containers.

Availability

FUSE-IT lost circulation material can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

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Rev.05/2013

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

SPECIFICATIONS, JT30

	U.S.	METRIC
OPERATION		
Spindle speed, max	225 rpm	
Spindle torque, max	4,000 ft·lb	5420 N·m
Carriage thrust travel speed	120 fpm	37 m/min
Carriage pullback travel speed	120 fpm	37 m/min
Thrust force	24,800 lb	110 kN
Pullback force	30,000 lb	133 kN
Ground travel speed		
Forward	2.4 mph	3.9 km/h
Reverse	2.2 mph	3.5 km/h
POWER (TIER 3)		
Engine	Cummins® QSB4.5	
Fuel	Diesel	
Cooling medium	Liquid	
Injection	Direct	
Aspiration	Turbocharged & charge air cooled	
Number of cylinders	4	
Displacement	275 in^3	4.5 L
Bore	4.21 in	107 mm
Stroke	4.88 in	124 mm
Manufacturer's gross power rating	148 hp	110 kW
Rated speed	2,300 rpm	
Emissions compliance	EPA Tier 3	EU Stage IIIA
POWER (TIER 4i)		
Engine	Cummins QSB4.5	
Fuel	Diesel	
Cooling medium	Liquid	
Injection	Direct	
Aspiration	Turbocharged & charge air cooled	
Number of cylinders	4	
Displacement	275 in^3	4.5 L
Bore	4.21 in	107 mm
Stroke	4.88 in	124 mm
Manufacturer's gross power rating	160 hp	119 kW
Rated speed	2,300 rpm	
Emissions compliance	EPA Tier 4i	EU Stage IIIB
DIMENSIONS		
Transport length	221 in	5.61 m
Width	80 in	2.03 m
Width, w/cab	89 in	2.26 m
Transport height	94 in	2.39 m
Operating weight	17,075 lb	7750 kg
Operating weight, w/cab	17,975 lb	8153 kg
Entry angle	10-16°	
Angle of approach	19°	
Angle of approach, w/cab	15°	
Angle of departure	18°	

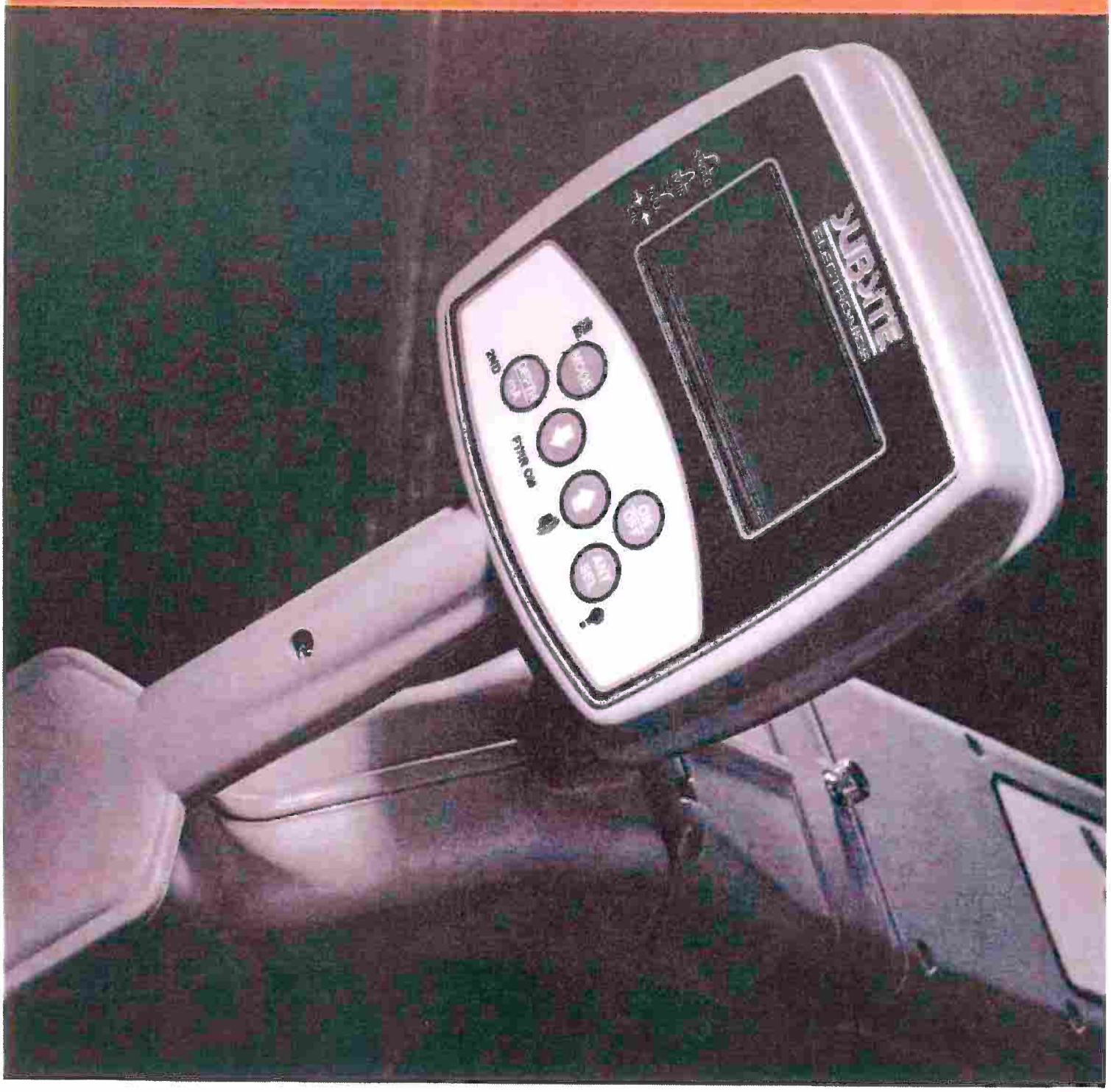
	U.S.	METRIC
DRILLING FLUID SYSTEM		
Pressure, max	1,500 psi	103 bar
Flow, max	50 gpm	189 l/min
FLUID CAPACITIES		
Hydraulic reservoir	27 gal	102 L
Fuel tank	42 gal	159 L
Engine lubrication oil w/filter	12 qt	11 L
Engine cooling system	23 qt	22 L
Antifreeze tank	8 gal	30 L
POWER PIPE®		
Length	118 in	3 m
Joint diameter	3 in	76 mm
Pipe diameter	2.38 in	60 mm
Bend radius, min	155 ft	47 m
Weight of drill pipe, lined	88 lb	39 kg
Weight of drill pipe & large box (48 pipe)	5,500 lb	2500 kg
Weight of drill pipe & small box (24 pipe)	3,200 lb	1450 kg
POWER PIPE FORGED		
Length	118 in	3 m
Joint diameter	2.61 in	66 mm
Pipe diameter	2.38 in	60 mm
Bend radius, min	155 ft	47 m
Weight of drill pipe	73 lb	33 kg
BATTERY		
SAE reserve capacity rating	195 min	
SAE cold crank rating @ 0°F (-18°C)	950 amps	
NOISE LEVELS		
Operator sound	85 dBA	
Operator sound w/cab	85 dBA	

Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that shown.

EXHIBIT "C"

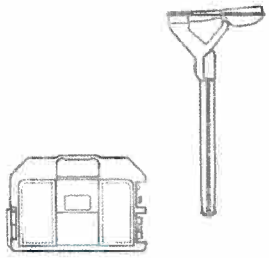
SUBSITE LOCATORS

> 950RXT > 970T > 810R
> EML SYSTEM
> AF2/FT14 > 2150GB



SUBSITE 950R/T AND 970T PIPE AND CABLE LOCATOR SYSTEM

LOCATION, LOCATION, LOCATION. The three modes and 20 frequencies of the 950R/T system help you quickly locate buried telephone, CATV, power, gas and water lines: Active — 950T and 970T transmit via direct line connection, induction clamp or induced broadcast signals; simultaneous 8 and 29 kHz transmission makes an alternate signal available if one is hard to detect, while higher frequencies help locate metallic lines with insulators that weaken or block low frequencies; Passive — 950R detects signals generated by 31 kHz (CATV) and 50/60 Hz power, as well as re-radiated radio frequencies; Beacon — 950R detects signals from optional beacons to locate non-metallic service lines; with the 512 beacon, the 950R locates blockages within cast-iron pipe.



KEY FEATURES

- Lightweight 950R receiver is balanced for easy handling.
- Enhanced backlit LCD offers optimal visibility in low-light conditions.
- 950T and 970T's rugged case and sealed keypad withstand tough weather conditions and provide superior moisture resistance.
- Patented digital signal processing (DSP) offers more effective locating and reduces interference; stable DSP depth readings do not vary with temperature or time, as analog readings do.

950R RECEIVER

Dimensions	U.S.	Metric
Length	12.8 in	325 mm
Width	5.9 in	145 mm
Height	27.75 in	705 mm
Operating Weight	4.5 lb	2 kg

Operation		
Operating Temperature Range	-4° F to 122° F	-20° C to 50° C
Antenna Configurations	Single peak, twin peak, null, left/right (line only)	
Audio Output	Speaker	
Operating Modes		
Active Line (standard)	512 Hz, 1 kHz, 8 kHz, 29 kHz, 80 kHz, 200 kHz, 33 kHz (EML)	
Active Line (optional)	400 Hz, 560 Hz, 815 Hz	
Beacon (locate/depth only)	512 Hz, 29 kHz, 33 kHz	
Passive Line (standard)	50 Hz, 60 Hz	
Passive Line (optional)	50 P power, 60 P power, 31 kHz	
Radio (optional)	Passive locate only, no depth available	
Locating Range		
Lines	15 ft	4.6 m
Beacons	10 ft	3 m
Depth estimate tolerances**		
Active line ± 3%	0.2-5 ft	0.06-1.5 m
Active line ± 5%	5-10 ft	1.5-3 m
Active line ± 10%	10 ft and deeper	3 m and deeper
Passive line ± 10%	0.5-10 ft	1.5-3 m
Beacon ± 5%	0.5-10 ft	1.5-3 m
LCD Backlight	LED (green)	
External Ports	RS-232 serial	

Batteries	
Type	6 C-cell alkaline
Battery Life	Approximately 50 hours (continuous use at 70° F / 21° C)
Battery Saver	Unit shuts off after 5 minutes of inactivity

950T TRANSMITTER

Dimensions	U.S.	Metric
Length	14 in	355 mm
Width	4.2 in	107 mm
Height	11 in	280 mm
Operating Weight	7.25 lb	3.3 kg

Operation		
Operating Temperature Range	-4° F to 122° F	-20° C to 50° C
Maximum Power Output	3 watts	3 watts
Operating Modes	512 Hz, 1 kHz, 8 kHz, 29 kHz, 80 kHz, and dual (8 kHz and 29 kHz)	
Timer	Unit runs continuously or shuts off after running for selected hour interval (8-hour maximum)	

Batteries	
Type	8 D-cell alkaline
Battery Life	Approximately 40 hours (continuous use at power level 2)

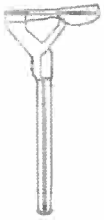
970T TRANSMITTER

Dimensions	U.S.	Metric
Length	14 in	355 mm
Width	4.2 in	107 mm
Height	11 in	280 mm
Operating weight	7.25 lb	3.3 kg

Operation		
Operating temperature range	-4° F to 122° F	-20° C to 50° C
Maximum power output	5 watts	5 watts
Operating modes	512 Hz, 1 kHz, 8 kHz, 29 kHz, 80 kHz, 200 kHz (optional), and dual (8 kHz and 29 kHz)	
Timer	Unit runs continuously or shuts off after running for selected hour interval (8-hour maximum)	

Batteries	
Type	8 D-cell alkaline
Battery Life	Approximately 80 hours (continuous use at power level 2)

**Locators are calibrated to these tolerances under ideal test field conditions. Actual operating field conditions may have signal distortions or may contain noise sources which result in depth estimates accuracy that is less than specified.*



SUBSITE 810R PIPE AND CABLE LOCATOR

MORE CHOICES MEAN BETTER RESULTS. The 910R receiver allows you to select the frequencies that best suit the application, whether you are locating pipe, cable, or non-directional beacons. Built on the same platform as the highly productive 950R, the 910R comes standard with up to four frequencies (see list below right), while additional frequencies may be added for a small fee. Active frequencies can be transmitted by 950T or 970T transmitters, and passive frequencies are used in cable avoidance sweeps or in the location of buried power and CATV lines. No matter what frequency you choose, the 910R gets to the bottom of things.

910R RECEIVER SPECIFICATIONS

	U.S.	Metric
Dimensions		
Length	12.8 in	325 mm
Height	27.75 in	705 mm
Width	5.9 in	145 mm
Operating Weight	4.5 lb	2 kg
Operation		
Operating Temperature Range	-4° F to 122° F	-20° C to 50° C
Antenna Configurations	Single peak, twin peak, null, left/right (line only)	
Audio Output	Speaker	
Locating Ranges		
Lines	15 ft	4.6 m
Beacons (in cast-iron pipe)	10 ft	3 m
Beacons (in plastic pipe)	15 ft	4.6 m
Maximum Depth Ranges		
Passive line	0.5-10 ft	0.15-3 m
Beacon	0.5-15 ft	0.15-4.6 m
Depth estimate tolerances**		
Active line ± 3%	0.2-5 ft	0.06-1.5 m
Active line ± 5%	5-10 ft	1.5-3 m
Active line ± 10%	10 ft and deeper	3 m and deeper
Passive line ± 10%	0.5-10 ft	1.5-3 m
Beacon ± 5%	0.5-10 ft	1.5-3 m
LCD Backlight	LED (green)	
External Ports	RS-232 serial	
Batteries		
Type	6 C-cell alkaline	
Battery Life	Approximately 50 hours (continuous use at 70° F / 21° C)	
Battery Saver	Unit shuts off after 5 minutes of inactivity	

***Locators are calibrated to these tolerances under ideal test field conditions. Actual operating field conditions may have signal distortions or may contain noise sources which result in depth estimates accuracy that is less than specified.*

910R FREQUENCY OPTIONS

Active
- 512 Hz
- 1 kHz
- 8 kHz
- 29 kHz
- 80 kHz
- 200 kHz

Power Passive
- 50 Hz
- 60 Hz
- 100 Hz
- 120 Hz
- 50 P
- 60 P

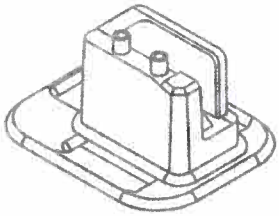
Beacon (non-roll)
- 512 Hz
- 29 kHz
- 33 kHz

LMS
- 400 Hz
- 560 Hz
- 815 Hz

Others
- 31 kHz CATV Passive
- 33 kHz EML
- Radio Passive (no depth capability)

SUBSITE ELECTRONIC MARKER LOCATOR

CALL OFF THE SEARCH: the Subsite EML accessory virtually eliminates the search for buried facilities when properly marked with 3M ScotchMark™ Electronic Markers. When buried with the facility, these markers serve as signaling devices. Each marker is color-coded to APWA standards and produces an industry-specific frequency that is pinpointed by the Subsite 910R or 950R locator and EML. With the Subsite EML, your identity problem is over.

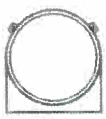


KEY FEATURES

- Easy to use; the locator transmits a signal to the
- Metallic conductors, fences, AC power lines or ot
- Electronic Markers can be buried over key faciliti
- Marker's passive antenna requires no internal pov
- Water-resistant polyethylene shells withstand mir

ELECTRONIC MARKERS SPECIFICATIONS

EML Locator Accessory — Locates All 3M Markers	
Weight	2.3 lb (1.1 kg)
Shipping Weight	4.0 lb (1.8 kg)
Battery Life	40 hours (typical)
Batteries	6 AA Alkaline
Temperature Range	-4° to 122° F (-20° to 50° C) operating
Storage	-40° to 158° F (-40° to 70° C)



Description	Utility
Full-Range Marker	Telephone
Full-Range Marker	Power
Full-Range Marker	Water
Full-Range Marker	Wastewater
Full-Range Marker	Gas

Description	Utility
Mid-Range Marker	Telephone
Mid-Range Marker	Power
Mid-Range Marker	Water
Mid-Range Marker	Wastewater
Mid-Range Marker	Gas

Description	Utility
4" Ball Marker	Telephone
4" Ball Marker	Power
4" Ball Marker	Water
4" Ball Marker	Wastewater
4" Ball Marker	Gas
4" Ball Marker	CATV

Description	Utility
Near-Surface Marker	Telephone
Near-Surface Marker	Power
Near-Surface Marker	Water
Near-Surface Marker	Wastewater
Near-Surface Marker	Gas

ıuried marker, and the marker returns a signal to the EML; location of the marker is indicated by an audible tone from the locator.
ıer utility electronic markers will not affect the locating process.
s such as valve boxes, splices, service stubs, and cable paths during construction or at the time of maintenance.
'er source.
ɛrals, chemicals, and underground temperature extremes.

Range	Color Code	Frequencies
8 ft (2.4 m)	Orange	101.4 kHz
8 ft (2.4 m)	Red	169.8 kHz
8 ft (2.4 m)	Blue	145.7 kHz
8 ft (2.4 m)	Green	121.6 kHz
8 ft (2.4 m)	Yellow	83 kHz

Shipping Weight	1.75 lb (0.08 kg) each, 44 lb (19.9 kg) per case
Product Size	15" diameter x 1" thick (3810 mm x 250 mm)
Shipping Quantities	25 per case, 200 per pallet

Range	Color Code	Frequencies
6 ft (1.8 m)	Orange	101.4 kHz
6 ft (1.8 m)	Red	169.8 kHz
6 ft (1.8 m)	Blue	145.7 kHz
6 ft (1.8 m)	Green	121.6 kHz
6 ft (1.8 m)	Yellow	83 kHz

Shipping Weight	5 oz (141.8 g) each, 17 lb (7.7 kg) per case
Product Size	8.25" diameter x 1.25" thick (2090 mm x 320 mm)
Shipping Quantities	50 per case, 600 per pallet

Range	Color Code	Frequencies
4 ft (1.2 m)	Orange	101.4 kHz
4 ft (1.2 m)	Red	169.8 kHz
4 ft (1.2 m)	Blue	145.7 kHz
4 ft (1.2 m)	Green	121.6 kHz
4 ft (1.2 m)	Yellow	83 kHz
4 ft (1.2 m)	Black/Orange	77 kHz

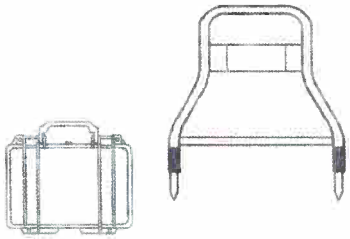
Shipping Weight	1 lb (0.45 kg) each, 25 lb (11.35) kg per case
Product Size	4" (1020 mm) diameter sphere
Shipping Quantities	24 per case, 576 per pallet

Range	Color Code	Frequencies
2 ft (0.6 m)	Orange	101.4 kHz
2 ft (0.6 m)	Red	169.8 kHz
2 ft (0.6 m)	Blue	145.7 kHz
2 ft (0.6 m)	Green	121.6 kHz
2 ft (0.6 m)	Yellow	83 kHz

Shipping Weight	0.88 oz (24.9 g) each, 3.75 lb (1.71 kg) per case
Product Size	3" length x 0.75" diameter (890 mm x 160 mm)
Shipping Quantities	50 per case (pallet N/A)

SUBSITE AF2/FT14 FAULT LOCATING SYSTEM

YOU'LL FIND PLENTY OF FAULTS with the Subsite AF2 A-frame detector and FT14 fault transmitter system. This sophisticated, extremely accurate system locates secondary faults in direct-buried, unshielded cables to within inches—at streetlight circuits and meter risers; across driveways, sidewalks, and streets; and even under snow or frozen ground. The FT14 places high-voltage, pulsed DC signals on target lines, breaking down corrosive buildup in the process; the AF2 then probes the ground to locate leakages and pinpoint faults. The AF2 features a remote probe extender for locating faults around obstacles. Let the AF2/FT14 system point out your faults.



AF2 A-FRAME DETECTOR SPECIFICATIONS

Battery	Alkaline 9VDC (1)
Sensitivity	Adjustable
Balance (meter centering)	Adjustable
Direction Indicator	Analog meter is intended to show direction to the fault when the detector orientation is correct (red probe toward the transmitter, black probe down the cable path)
Battery Indicator	Indicates battery condition
Remote Probe	On/off, electronically disconnects the red A-frame probe and connects the remote probe

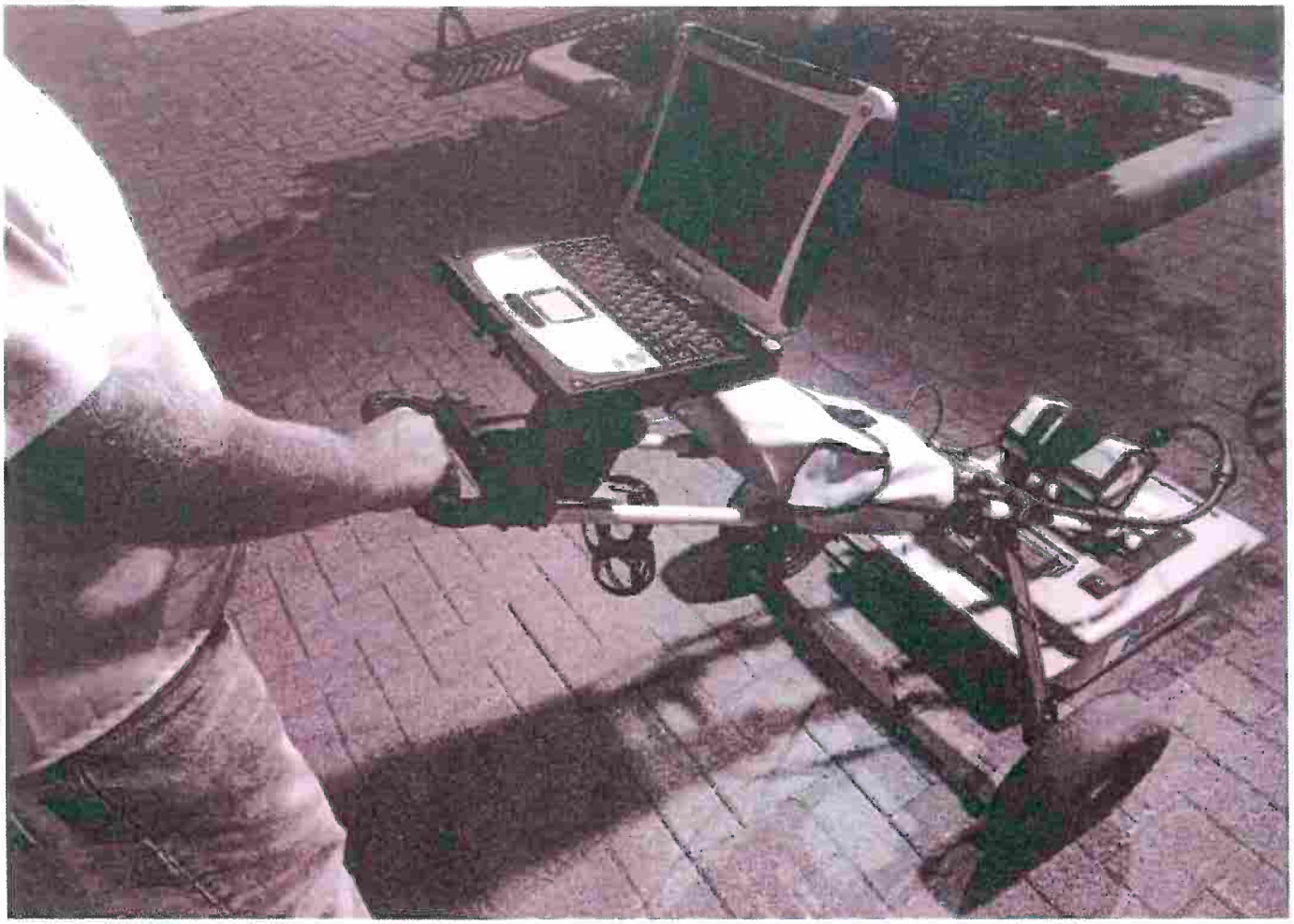
FT14 TRANSMITTER SPECIFICATIONS

Battery	"D" alkaline (6) or external 12VDC source 12VDC @ 24 watts – pulsing 12VDC @ 0.5 watts – normal 12VDC inputs protected with 4-amp panel mount fuse (inside battery compartment)
Battery Indicator	Indicates battery condition
Output Voltage	2300-2500VDC initial, across 10-megaohm load Output pulse rate is one pulse every 3-4 seconds Output pulse duration is typically 200 milliseconds
Fault Impedance Indicator	Gives approximate value to fault
Output Tone	User selectable on/off
Output Light	User selectable on/off

KEY FEATURES

- Unique system that serves a variety of industries, including One-Call contractors, power and communications utility companies, general contractors, and subsurface utility engineering contractors.
- Ruggedly built; designed to withstand heavy use in a wide variety of conditions.
- Corresponding transmitter pulse, sound, and indicator light; improved transmitter battery holders; and faster settle time and less back swing.


AF2



SUBSITE 2150GR GROUND PENETRATING RADAR

LOOK OUT BELOW. Here comes the Subsite 2150GR, our most extensive, sophisticated locating system. The 2150GR detects both metallic and non-metallic pipes and cables to depths of up to 19 feet (6 m), depending on soil conditions and antenna selection. With 5.6 mph (9 km/h) survey speed—four times faster than that of competitive models—and digitally controlled radar, the 2150GR provides faster, cleaner images. For municipalities, subsurface utility engineers, school systems, and other organizations with significant infrastructure and outdated utility maps, the 2150GR puts everything in perspective.

2150GR SPECIFICATIONS

System	U.S.	Metric
Languages	English, French, German, Spanish, Italian, Portuguese, Chinese	
Data collection type	Parallel profile lines, perpendicular to the expected orientation of utilities	
Survey path width	19.7 in	500 mm
Recording channels	1	
Transmitting frequency	100 kHz	
Typical antenna frequency	250 or 700 mHz	
Typical collection speed (scans/second)	100	100
Typical collection speed @ 2" (5-cm) sampling interval	5.6 mph	9 km/h
Display mode	Gray scale/color palette	
Zoom	Up to 4X	
Data storage	Onto the laptop hard drive	
Maximum profile length	Virtually unlimited	
Stored data format	Raw data (for further data analysis)	
Setting of GPR propagation velocity (to get accurate evaluation of depth of detected targets)	Ground truth or hyperbola fitting methods	
Reading of pipe position/depth	By a software cursor	
System output	Printable radar map with descriptor of detected utilities	
Diagnostic	Radar and power supply status, excessive speed, data loss	
Radar Power Requirements		
Battery operating time	>10 hours	
Power supply	12^{V} sealed lead acid, 12Ah	
Mechanical/Environmental		
Operating temperature	14° F to 104° F	-10° C to 40° C
Humidity	100% (sealed)	
Weight (without battery)	19.8 lb	9 kg
Length (without handle)	26.7 in	680 mm
Width (without handle)	31.4 in	800 mm
Environmental	IP65	
250 MHz Antenna Performance		
Antenna technology	Ultra-wide band, ground coupled, shielded dipole	
Typical range	0.6-8.2 ft	0.2-2.5 m
Maximum range	0.6-19.7 ft	0.2-6.0 m
700 MHz Antenna Performance		
Antenna technology	Ultra-wide band, ground coupled, shielded dipole	
Typical range	0.32-4.9 ft	0.1-1.5 m
Maximum range	0.32-8.2 ft	0.1-2.5 m

Unless otherwise specified, all figures are for standard equipment only. Specifications are called out according to SAE recommended procedures. Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that described.

KEY FEATURES

- 2150GR provides an accurate survey whether the operator is pushing or pulling it across any surface.
- User-friendly software enables the operator to manually input landmarks such as water hydrants and sewer drains, for more accurate survey maps.
- Digitally controlled radar provides faster survey speed—up to four times faster than competitive models—and better images.
- Earth-engaged antenna provides better contact on uneven terrain and reduces signal loss.
- Data recording and storage capabilities provide on-site data review, post-collection analysis, and proof of work when jobs require it.
- Two interchangeable antenna options to customize the unit for the job conditions.
- Auto-calibrating gain and filter take the guesswork out of setup.
- Folds for easy transport in a standard car trunk.

Subsite® Electronics has the most complete line of pipe and cable locators and the fastest service in the industry.
For more information about these products, contact your local Subsite or Ditch Witch® equipment dealer.

1950 W. Fir Avenue
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SUBSITE
ELECTRONICS

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Iron Pipe Size (IPS) and Dimension Data

PE4710 (PE3408)

DriscoPlex® Pipe for Municipal and Industrial Applications

Pressure Ratings are calculated using 0.63 design factor for HDS at 73°F as listed in PPI TR-4 for PE 4710 materials. HDPE can accomodate up to 1.5 times the pipe pressure rating for a recurring surge and up to 2.0 times the pipe pressure rating for an occasional surge. Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

Pressure Rating		317 psi DR 7.3			250 psi DR 9.0			200 psi DR 11.0			160 psi DR 13.5			
Nominal Pipe Size	IPS OD (in)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Nominal Pipe Size
1 1/4"	1.660	0.227	1.179	0.45	0.184	1.270	0.37	0.151	1.340	0.31	0.123	1.399	0.26	1 1/4"
1 1/2"	1.900	0.260	1.349	0.59	0.211	1.453	0.49	0.173	1.533	0.41	0.141	1.601	0.34	1 1/2"
2"	2.375	0.325	1.686	0.92	0.264	1.815	0.77	0.216	1.917	0.64	0.176	2.002	0.53	2"
3"	3.500	0.479	2.485	1.99	0.389	2.675	1.66	0.318	2.826	1.39	0.259	2.951	1.16	3"
4"	4.500	0.616	3.194	3.29	0.500	3.440	2.75	0.409	3.633	2.31	0.333	3.794	1.92	4"
6"	6.625	0.908	4.700	7.12	0.736	5.065	5.96	0.602	5.349	5.00	0.491	5.584	4.15	6"
8"	8.625	1.182	6.119	12.07	0.958	6.594	10.11	0.784	6.963	8.47	0.639	7.270	7.04	8"
10"	10.750	1.473	7.627	18.75	1.194	8.219	15.70	0.977	8.679	13.16	0.796	9.062	10.93	10"
12"	12.750	1.747	9.046	26.39	1.417	9.746	22.08	1.159	10.293	18.51	0.944	10.749	15.38	12"
14"	14.000	1.918	9.934	31.81	1.556	10.701	26.63	1.273	11.301	22.32	1.037	11.802	18.54	14"
16"	16.000	2.192	11.353	41.56	1.778	12.231	34.78	1.455	12.915	29.15	1.185	13.486	24.22	16"
18"	18.000	2.466	12.772	52.58	2.000	13.750	44.02	1.636	14.532	36.89	1.333	15.174	30.65	18"
20"	20.000	2.740	14.191	64.91	2.222	15.280	54.34	1.818	16.146	45.54	1.481	16.860	37.84	20"
22"	22.000	3.014	15.610	78.55	2.444	16.810	65.75	2.000	17.760	55.10	1.630	18.544	45.79	22"
24"	24.000	3.288	17.029	93.48	2.667	18.346	78.25	2.182	19.374	65.58	1.778	20.231	54.49	24"
26"	26.000				2.889	19.875	91.84	2.364	20.988	76.96	1.926	21.917	63.95	26"
28"	28.000				3.111	21.405	106.51	2.545	22.605	89.26	2.074	23.603	74.17	28"
30"	30.000				3.333	22.934	122.27	2.727	24.219	102.47	2.222	25.289	85.14	30"
32"	32.000				3.556	24.462	139.12	2.909	25.833	116.58	2.370	26.976	96.87	32"
34"	34.000				3.778	25.991	157.05	3.091	27.447	131.81	2.519	28.680	109.36	34"
36"	36.000				4.000	27.520	176.07	3.273	29.061	147.55	2.667	30.348	122.60	36"
42"	42.000							3.818	33.906	200.84	3.111	35.405	166.88	42"
48"	48.000													48"
54"	54.000													54"

This size and dimension chart is intended for reference purposes. It should not be used in place of the advice from a licensed Professional Engineer. Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter is calculated using IPS OD and Minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimension and tolerances in the applicable pipe manufacturing specification.

Visit www.performancepipe.com for the most current literature.

EXHIBIT "D"

August 2014 Supersedes all previous publications
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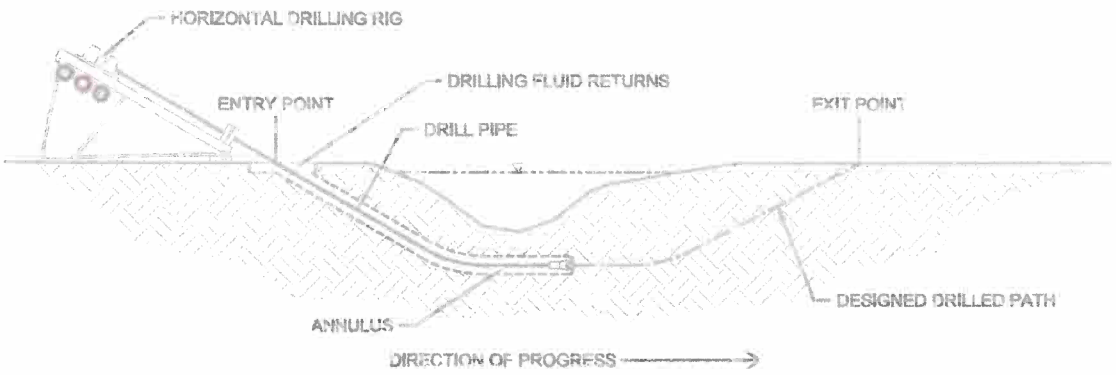
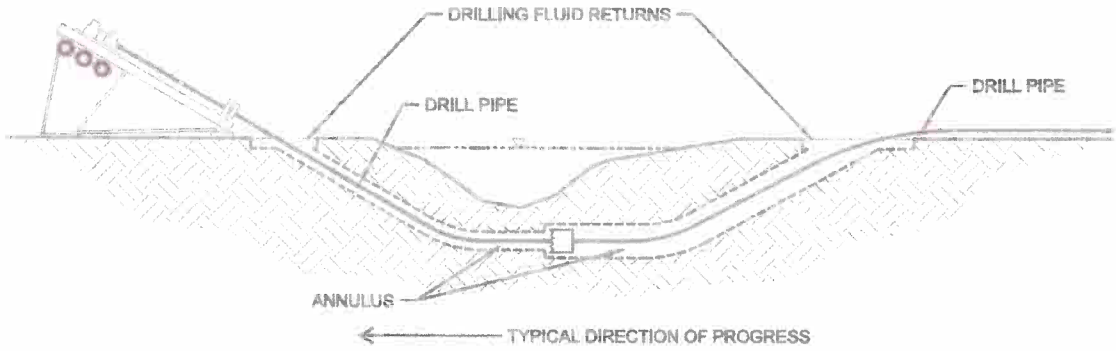
EXHIBIT "E"

PILOT HOLE



PREREAMING



PULLBACK

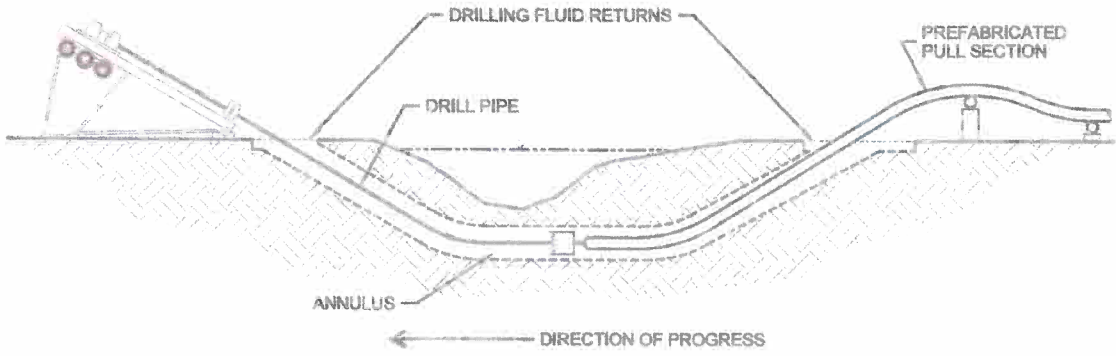


Figure 1
The HDD Process

 EXHIBIT F

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#12 CCS Extra High Strength Hard Drawn 1150# (SoloShot)

Product Purchasing Description

Direct Burial #12 AWG Solid (.0808" diameter), steel core hard drawn extra high strength horizontal directional drill tracer wire, 1150# average tensile break load, 45 mil high molecular weight-high density yellow polyethylene jacket complying with ASTM-D-1248, 30 volt rating.

Part #s: 1245*-EHS-500 / 1245*-EHS-1000 / 1245*-EHS-2500

Part # Description:

12(AWG), 45 (jacket mil), * (jacket color: Y= Yellow, B=Blue, R=Red, K= Black, N= Orange, G=Green)- EHS (extra high strength-hard drawn)-500(wire length in ft.)

Print Line:

Physical, permanent markings: surface legend print on insulating jacket to repeat at minimum interval of every two linear feet, reads as follows:

"COPPERHEAD * 12 AWG-SOLID EHS-CCS HORIZONTAL DIRECTIONAL DRILL TRACER WIRE * 45 MIL HDPE * 30 VOLT * DIRECT BURIAL ONLY"

Copperhead Reinforced Tracer Wire Spool Size and Weights

Part Number	Spool Length	Spool Size	Spool Material	Barrel Diameter	Arbor Hole	Per box	Shipping Wt. / box
1245-EHS-500	500 ft	6-1/2" flange x 9" long	High-Impact Polystyrene	1-15/16"	13/16"	4	53 lbs
1245-EHS-1000	1000 ft	8-1/2" flange x 7" long	Stamped Metal	2"	3/4"	2	53 lbs
1245-EHS-2500	2500 ft	14" flange x 10" long	Plywood	5"	1 9/16"	1	67 lbs

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